Physics 137B Section 1: Problem Set #9
Due: 5PM Friday April 16 in 2nd floor LeConte-Birge Cross-Over

Suggested Reading for this Week:

- Bransden and Joachain (B& J) Sections 11.2 - 11.7 (Note: we did not cover the section going from the bottom of page 531 through page 532 or pages 548-550)
- B& J Sections 12.1 - 12.3

Homework Problems:

1. B& J is *very* sloppy on page 537 in its use of the term *half-life*. The half-life of an excited state is defined as the time it would take for half the atoms in a large sample to decay. Using Equation 11.114, find a relationship between the half-life $t_{\frac{1}{2}}$ and τ.
2. (adapted from Griffith problem 9.13) An electron in the $n=3$, $\ell=0$, $m=0$ state of hydrogen decays by a sequence of electric dipole transitions to the ground state.
   (a) What decay routes are open to it? Specify them in the following way:
   $$|300\rangle \rightarrow |n\ell m\rangle \rightarrow ... \rightarrow |100\rangle$$
   (b) If you had a bottle full of atoms in this state, what fraction of them would decay via each route?
   (c) What is the lifetime of this state? Hint: Once it's made the first transition, it is no longer in the $|300\rangle$ state so only the *first* step in each sequence is relevant in computing the lifetime. When there is more than one decay route open, the transition *rates* add.
   (d) Using the results you have calculated here, draw the equivalent of B& J Figure 11.3 where you put numerical values on the x axis.

3. (Griffiths problem 6.19) Consider the eight $n = 2$ states $\left|2\ell m_j\right\rangle$. Find the energy of each state, under weak-field Zeeman splitting.

4. (Griffiths problem 6.21 Repeat the last problem under strong-field Zeeman splitting.